WHAT IS CLAIMED IS:

1. An alloyed semiconductor quantum dot comprising an alloy of at least two semiconductors, wherein the quantum dot has a homogeneous composition and is characterized by a band gap energy that is non-linearly related to the molar ratio of the at least two semiconductors.

2. The alloyed semiconductor quantum dot of claim 1, wherein the quantum dot has a quantum yield that is at least about 15%.

3. The alloyed semiconductor quantum dot of claim 2, wherein the quantum yield is within the range of about 30% and about 60%.

4. The alloyed semiconductor quantum dot of claim 3, wherein the quantum yield is within the range of about 40% and about 60%.

5. The alloyed semiconductor quantum dot of claim 1, wherein each of the at least two semiconductors has a lattice parameter that is within about 10% of the mean lattice parameter.

6. The alloyed semiconductor quantum dot of claim 1, wherein at least one of the at least two semiconductors is a Group II-Group VI semiconductor or a Group III-Group V semiconductor.

7. The alloyed semiconductor quantum dot of claim 6, wherein the quantum dot comprises an alloy selected from the group consisting of CdSeTe, CdSSe, CdSTe, ZnSeTe, ZnCdTe, CdHgS, HgCdTe, InGaAs, GaAlAs, and InGaN.

8. The alloyed semiconductor quantum dot of claim 7, wherein the alloy comprises CdSeTe and has a molecular formula $CdSe_{1-x}Te_x$, wherein the alloy comprises CdSSe and has a molecular formula $CdS_{1-x}Se_x$, the alloy comprises CdSTe and has a molecular formula $CdS_{1-x}Te_x$, the alloy comprises ZnSeTe and has a molecular formula $ZnSe_{1-x}Te_x$, the alloy comprises ZnCdTe and has a molecular formula $Zn_{1-x}Cd_xTe$, the alloy comprises CdHgS and has a molecular formula $Cd_{1-x}Hg_xS$, the alloy comprises HgCdTe and has a molecular formula HgCdTe, the alloy comprises InGaAs and has a molecular formula InGaAs, the alloy comprises GaAlAs and has a molecular formula GaAlAs, or the alloy comprises InGaN and has a molecular formula InGaN, wherein x is any fraction between 0 and 1.

9. The alloyed semiconductor quantum dot of claim 1, wherein at least one of the at least two semiconductors is a compound semiconductor.

10. The alloyed semiconductor quantum dot of claim 9, wherein the compound semiconductor is CdSe.

11. The alloyed semiconductor quantum dot of claim 9, wherein the compound semiconductor is CdTe.

12. The alloyed semiconductor quantum dot of claim 1, wherein the at least two semiconductors are CdSe and CdTe.

13. The alloyed semiconductor quantum dot of claim 1, wherein the quantum dot is less than 15 nm in diameter.

14. The alloyed semiconductor quantum dot of claim 13, wherein the quantum dot is less than 8 nm in diameter.

15. The alloyed semiconductor quantum dot of claim 1, wherein the quantum dot is conjugated to a biological agent.

16. The alloyed semiconductor quantum dot of claim 15, wherein the biological agent is a biomolecule or a drug.

17. The alloyed semiconductor quantum dot of claim 16, wherein the biomolecule is selected from the group consisting of a protein, a peptide, a nucleic acid molecule, and a combination thereof.

18. The alloyed semiconductor quantum dot of claim 1, wherein the alloyed semiconductor quantum dot has a semiconductor shell.

19. The alloyed semiconductor quantum dot of claim 18, wherein the semiconductor shell comprises ZnS, CdS, CdSe, CdTe, GaAs, or AlGaAs.

20. The alloyed semiconductor quantum dot of claim 1, wherein the quantum dot is encapsulated within a polymer bead.

21. The alloyed semiconductor quantum dot of claim 20, wherein the polymer bead comprises a polymer selected from the group consisting of polystyrene, brominated polystyrene, polyacrylic acid, polyacrylonitrile, polyamide, polyacrylamide, polyacrolein, polybutadiene, polycaprolactone, polycarbonate, polyester, polyethylene, polyethylene terephthalate, polydimethylsiloxane, polyisoprene, polyurethane, polyvinyl acetate, polyvinyl chloride, polyvinyl pyridine, polyvinylbenzyl chloride, polyvinyl toluene, polyvinylidene chloride, polydivinylbenzene, polymethylmethacrylate, polylactide, polyglycolide, poly(lactide-co-glycolide), polyanhydride, polyorthoester, polyphosphazene, polysulfone, and a combination or a copolymer thereof.

22. A series of alloyed semiconductor quantum dots,

wherein each alloyed semiconductor quantum dot of the series comprises an alloy of at least two semiconductors and has a homogeneous composition,

wherein the size of each quantum dot is within about 5% of the size of the average-sized quantum dot,

wherein each of the alloyed semiconductor quantum dots of the series comprises the same alloy, but varies in molar ratio of the at least two semiconductors, and

wherein at least one of the alloyed semiconductor quantum dots of the series is characterized by a band gap energy that is non-linearly related to the molar ratio of the at least two semiconductors.

23. The series of alloyed semiconductor quantum dots of claim 22, wherein all of the alloyed semiconductor quantum dots of the series are characterized by a band gap energy that is non-linearly related to the molar ratio of the of the at least two semiconductors.

24. The series of alloyed semiconductor quantum dots of claim 22, wherein the alloyed semiconductor quantum dots have a quantum yield that is at least about 15%.

25. The series of alloyed semiconductor quantum dots of claim 24, wherein the quantum yield is within the range of about 30% and about 60%.

26. The series of alloyed semiconductor quantum dots of claim 25, wherein the quantum yield is within the range of about 40% and about 60%.

27. The series of alloyed semiconductor quantum dots of claim 22, wherein each of the at least two semiconductors has a lattice parameter that is within about 10% of the mean lattice parameter.

28. The series of alloyed semiconductor quantum dots of claim 22, wherein at least one of the at least two semiconductors is a Group II-Group VI semiconductor or a Group III-Group V semiconductor.

29. The series of alloyed semiconductor quantum dots of claim 28, wherein the quantum dot comprises an alloy selected from the group consisting of CdSeTe, CdSSe, CdSTe, ZnSeTe, ZnCdTe, CdHgS, HgCdTe, InGaAs, GaAlAs, and InGaN.

30. The series of alloyed semiconductor quantum dots of claim 29, wherein the alloy comprises CdSeTe and has a molecular formula $CdSe_{1-x}Te_x$, wherein the alloy comprises CdSSe and has a molecular formula $CdS_{1-x}Se_x$, the alloy comprises CdSTe and has a molecular formula $CdS_{1-x}Te_x$, the alloy comprises ZnSeTe and has a molecular formula $ZnSe_{1-x}Te_x$, the alloy comprises ZnCdTe and has a molecular formula $Zn_{1-x}Cd_xTe$, the alloy comprises CdHgS and has a molecular formula $Cd_{1-x}Hg_xS$, the alloy comprises HgCdTe and has a molecular formula HgCdTe, the alloy comprises InGaAs and has a molecular formula InGaAs, the alloy comprises GaAlAs and has a molecular formula GaAlAs, or the alloy comprises InGaN and has a molecular formula InGaN, wherein x is any fraction between 0 and 1.

31. The series of alloyed semiconductor quantum dots of claim 22, wherein at least one of the at least two semiconductors is a compound semiconductor.

32. The series of alloyed semiconductor quantum dots of claim 31, wherein the compound semiconductor is CdSe.

33. The series of alloyed semiconductor quantum dots of claim 31, wherein the compound semiconductor is CdTe.

34. The series of alloyed semiconductor quantum dots of claim 22, wherein the at least two semiconductors are CdSe and CdTe.

35. The series of alloyed semiconductor quantum dots of claim 22, wherein the quantum dots are less than 15 nm in diameter.

36. The series of alloyed semiconductor quantum dots of claim 35, wherein the quantum dots are less than 8 nm in diameter.

37. The series of alloyed semiconductor quantum dots of claim 22, wherein each of the quantum dots is conjugated to a biological agent.

38. The series of alloyed semiconductor quantum dots of claim 37, wherein the biological agent is a biomolecule or a drug.

39. The series of alloyed semiconductor quantum dots of claim 38, wherein the biomolecule is selected from the group consisting of a protein, a peptide, a nucleic acid molecule, and a combination thereof.

40. The series of alloyed semiconductor quantum dots of claim 37, wherein each of the quantum dots is conjugated to a different biological agent, such that each of the different biological agents corresponds to a quantum dot having a unique molar ratio of the at least two semiconductors.

41. The series of alloyed semiconductor quantum dots of claim 40, wherein each of the biological agents is a biomolecule or a drug.

42. The series of alloyed semiconductor quantum dots of claim 41, wherein the biomolecules are selected from the group consisting of a protein, a peptide, a nucleic acid molecule, and a combination thereof.

43. The series of alloyed semiconductor quantum dots of claim 22, wherein each of the alloyed semiconductor quantum dots has a semiconductor shell.

44. The series of alloyed semiconductor quantum dots of claim 43, wherein the semiconductor shell comprises ZnS, CdS, CdSe, CdTe, GaAs, or AlGaAs.

45. The series of alloyed semiconductor quantum dots of claim 22, wherein each of the quantum dots is encapsulated within a polymer bead.

46. The series of alloyed semiconductor quantum dots of claim 45, wherein the polymer bead comprises a polymer selected from the group consisting of polystyrene, brominated

polystyrene, polyacrylic acid, polyacrylonitrile, polyamide, polyacrylamide, polyacrolein, polybutadiene, polycaprolactone, polycarbonate, polyester, polyethylene, polyethylene terephthalate, polydimethylsiloxane, polyisoprene, polyurethane, polyvinyl acetate, polyvinyl chloride, polyvinyl pyridine, polyvinylbenzyl chloride, polyvinyl toluene, polyvinylidene chloride, polydivinylbenzene, polymethylmethacrylate, polylactide, polyglycolide, poly(lactide-co-glycolide), polyanhydride, polyorthoester, polyphosphazene, polysulfone, and a combination or a copolymer thereof.

47. A method of detecting a target in a sample, which method comprises:
   (i) contacting a sample with the alloyed semiconductor quantum dot of claim 15, wherein the biological agent specifically binds to a target in the sample,
   (ii) allowing the biological agent to specifically bind to the target, and
   (iii) analyzing the sample via spectroscopy, thereby obtaining a spectroscopic signature of the sample, wherein the spectroscopic signature is indicative of the presence or the absence of the target in the sample.

48. The method of claim 47, wherein the sample is obtained from a mammal.

49. The method of claim 48, wherein the mammal is a human.

50. The method of claim 48, wherein the mammal has a disease or a condition and the method achieves detection of the disease or the condition.

51. A method of detecting more than one target in a sample, which method comprises:
   (i) contacting a sample with the series of alloyed semiconductor quantum dots of claim 40, wherein each of the biological agents specifically bind to a different target in the sample,
   (ii) allowing the biological agents to specifically bind to the targets,
   (iii) analyzing the sample via spectroscopy, thereby obtaining a spectroscopic signature of the sample, wherein the spectroscopic signature is indicative of the presence or absence of the more than one target in the sample.

52. The method of claim 51, wherein the sample is obtained from a mammal.

53. The method of claim 52, wherein the mammal is a human.

54. The method of claim 52, wherein the mammal has a disease or a condition and the method achieves detection of the disease or the condition.

55. A method of detecting the location of a target within a sample, which method comprises:

(i) contacting a sample with the alloyed semiconductor quantum dot of claim 15, wherein the biological agent specifically binds to a target in the sample,
(ii) allowing the biological agent to specifically bind to the target,
(iii) imaging the sample or a section thereof, thereby detecting the location of the target within the sample.

56. The method of claim 55, wherein the sample is obtained from a mammal.

57. The method of claim 56, wherein the mammal is a human.

58. The method of claim 56, wherein the mammal has a disease or a condition and the method achieves a prognosis of the disease or the condition.

59. The method of claim 58, wherein the disease is cancer.

60. A method of detecting the location of more than one target within a sample, which method comprises:

(i) contacting a sample with the series of alloyed semiconductor quantum dots of claim 40, wherein each of the biological agents specifically binds to a different target in the sample,
(ii) allowing the biological agents to specifically bind to the targets,
(iii) imaging the sample or a section thereof, thereby detecting the location of the more than one target within the sample.

61. The method of claim 60, wherein the sample is obtained from a mammal.

62. The method of claim 61, wherein the mammal is a human.

63. The method of claim 61, wherein the mammal has a disease or a condition and the method achieves a prognosis of the disease or the condition.

64. The method of claim 63, wherein the disease is cancer.

65. A method of monitoring a biological process *in vitro*, which method comprises:
    (i) contacting a sample with the alloyed semiconductor quantum dot of claim 15, wherein the biological agent specifically binds to a target in the sample, wherein the target functions in a biological process,
    (ii) allowing the biological agent to specifically bind to the target, and
    (iii) imaging the sample or a section thereof over a period of time or before and after a stimulus, thereby monitoring a biological process *in vitro*.

66. The method of claim 65, wherein the sample is obtained from a mammal.

67. The method of claim 66, wherein the mammal is a human.

68. The method of claim 66, wherein the mammal has a disease or a condition and the method achieves detection or prognosis of the disease or the condition.

69. A method of monitoring a biological process *in vitro*, which method comprises:
    (i) contacting a sample with the series of alloyed semiconductor quantum dots of claim 40, wherein each of the biological agents specifically binds to a different target in the sample, wherein each of the targets functions in a biological process,
    (ii) allowing the biological agents to specifically bind to the targets, and
    (iii) imaging the sample or a section thereof over a period of time or before and after a stimulus, thereby monitoring a biological process *in vitro*.

70. The method of claim 69, wherein the sample is obtained from a mammal.

71. The method of claim 70, wherein the mammal is a human.

72. The method of claim 70, wherein the mammal has a disease or a condition and the method achieves detection or prognosis of the disease or the condition.

73. A method of detecting the location of a target *in vivo*, which method comprises:
    (i) administering the alloyed quantum dot of claim 15 to a host, wherein the biological agent specifically binds to a target in the host,
    (ii) allowing the biological agent to specifically bind to the target,

(iii) imaging the host, a section thereof, or a cell thereof, thereby detecting the location of the target *in vivo*.

74. The method of claim 73, wherein the host is a mammal.

75. The method of claim 74, wherein the mammal is a human.

76. The method of claim 74, wherein the mammal has a disease or a condition and the method achieves a prognosis of the disease or the condition.

77. The method of claim 73, wherein the location of the target is deep within the host.

78. The method of claim 73, wherein the imaging involves detecting near infrared or far red emission peak wavelengths.

79. A method of detecting the location of more than one target *in vivo*, which method comprises:

(i) administering the series of alloyed quantum dots of claim 40 to a host, wherein each of the biological agents specifically binds to a different target in the host,

(ii) allowing the biological agents to specifically bind to the targets,

(iii) imaging the host, a section thereof, or a cell thereof, thereby detecting the location of the more than one target *in vivo*.

80. The method of claim 79, wherein the host is a mammal.

81. The method of claim 80, wherein the mammal is a human.

82. The method of claim 80, wherein the mammal has a disease or a condition and the method achieves a prognosis of the disease or the condition.

83. The method of claim 79, wherein the location of the target is deep within the host.

84. The method of claim 79, wherein the imaging involves detecting near infrared or far red emission peak wavelengths.

85. A method of monitoring a biological process *in vivo*, which method comprises:

(i) administering the alloyed semiconductor quantum dot of claim 15 to a host, wherein the biological agent specifically binds to a target in the host, wherein the target functions in a biological process,

(ii) allowing the biological agent to specifically bind to the target, and

(iii) imaging the host, a section, or a cell thereof over a period of time or before and after a stimulus, thereby monitoring a biological process *in vivo*.

86. The method of claim 85, wherein the host is a mammal.

87. The method of claim 86, wherein the mammal is a human.

88. The method of claim 86, wherein the mammal has a disease or a condition and the method achieves detection or prognosis of the disease or the condition.

89. The method of claim 85, wherein the location of the target is deep within the host.

90. The method of claim 85, wherein the imaging involves detecting near infrared or far red emission peak wavelengths.

91. A method of monitoring a biological process *in vivo*, which method comprises:

(i) administering the series of alloyed semiconductor quantum dots of claim 40 to a host, wherein each of the biological agents specifically binds to a different target in the host, wherein each of the targets functions in a biological process,

(ii) allowing the biological agents to specifically bind to the targets, and

(iii) imaging the host, a sample thereof, or a section thereof over a period of time or before and after a stimulus, thereby monitoring a biological process *in vivo*.

92. The method of claim 91, wherein the host is a mammal.

93. The method of claim 92, wherein the mammal is a human.

94. The method of claim 92, wherein the mammal has a disease or a condition and the method achieves detection or prognosis of the disease or the condition.

95. The method of claim 91, wherein the location of the target is deep within the host.

96. The method of claim 91, wherein the imaging involves detecting near infrared or far red emission peak wavelengths.

97. A method of producing a quantum dot comprising an alloy of at least two semiconductors, which method comprises:

(i) providing a first solution under conditions which allow nanocrystal formation to take place,

(ii) providing a second solution comprising precursors of the at least two semiconductors at a molar ratio under conditions which do not allow nanocrystal formation to take place,

(iii) adding the second solution to the first solution, thereby allowing nanocrystal formation to take place,

(iv) changing the conditions to conditions that halt nanocrystal growth and formation,

whereupon a quantum dot comprising an alloy of at least two semiconductors is produced.

98. A method of producing a ternary alloyed semiconductor quantum dot comprising an alloy of two semiconductors AB and AC, wherein A is a species that is common to the two semiconductors and B and C are each a species that is found in one of the two semiconductors, which method comprises:

(i) providing a first solution under conditions which allow nanocrystal formation to take place,

(ii) providing a second solution comprising A, B, and C under conditions which do not allow nanocrystal formation to take place, wherein A is present in the second solution at concentration that is reaction-limiting,

(iii) adding the second solution to the first solution, thereby allowing nanocrystal formation to take place,

(iv) changing the conditions to conditions that halt nanocrystal growth and formation.

99. A method of producing a series of ternary alloyed semiconductor quantum dots, wherein each quantum dot comprises an alloy of two semiconductors AB and AC, wherein A is a species that is common to the two semiconductors and B and C are each a species that is found in one of the two semiconductors, which method comprises:

(i) providing a first solution under conditions which allow nanocrystal formation to take place,

(ii) providing a second solution comprising A, B, and C at a molar ratio under conditions which do not allow nanocrystal formation to take place, wherein A is present in the second solution at concentration that is reaction-limiting,

(iii) adding the second solution to the first solution, thereby allowing nanocrystal formation to take place,

(iv) changing the conditions to conditions that halt nanocrystal growth and formation, and

(v) repeating steps (i) – (iv) at least one time, thereby producing at least one other quantum dot in the series, wherein each time the molar ratio of A, B, and C is different from the molar ratio of A, B, and C of the other quantum dots of the series.

100. An alloyed semiconductor quantum dot comprising an alloy of at least two semiconductors, wherein the quantum dot has an emission peak wavelength that is not within the range of wavelengths defined by the emission peak wavelengths of the quantum dots consisting of only one of the at least two semiconductors.

101. A concentration-gradient quantum dot comprising an alloy of a first semiconductor and a second semiconductor, wherein the concentration of the first semiconductor gradually increases from the core of the quantum dot to the surface of the quantum dot and the concentration of the second semiconductor gradually decreases from the core of the quantum dot to the surface of the quantum dot.

102. The concentration-gradient quantum dot of claim 101, wherein the quantum dot has a quantum yield that is at least about 15%.

103. The concentration-gradient quantum dot of claim 102, wherein the quantum yield is within the range of about 30% and about 60%.

104. The concentration-gradient quantum dot of claim 103, wherein the quantum yield is within the range of about 40% and about 60%.

105. The concentration-gradient quantum dot of claim 101, wherein each of the first semiconductor and second semiconductor has a lattice parameter that is within about 10% of the mean lattice parameter.

106. The concentration-gradient quantum dot of claim 101, wherein at least one of the first semiconductor and second semiconductor is a Group II-Group VI semiconductor or a Group III-Group V semiconductor.

107. The concentration-gradient quantum dot of claim 106, wherein the quantum dot comprises an alloy selected from the group consisting of CdSeTe, CdSSe, CdSTe, ZnSeTe, ZnCdTe, CdHgS, HgCdTe, InGaAs, GaAlAs, and InGaN.

108. The concentration-gradient quantum dot of claim 107, wherein the alloy comprises CdSeTe and has a molecular formula $CdSe_{1-x}Te_x$, wherein the alloy comprises CdSSe and has a molecular formula $CdS_{1-x}Se_x$, the alloy comprises CdSTe and has a molecular formula $CdS_{1-x}Te_x$, the alloy comprises ZnSeTe and has a molecular formula $ZnSe_{1-x}Te_x$, the alloy comprises ZnCdTe and has a molecular formula $Zn_{1-x}Cd_xTe$, the alloy comprises CdHgS and has a molecular formula $Cd_{1-x}Hg_xS$, the alloy comprises HgCdTe and has a molecular formula HgCdTe, the alloy comprises InGaAs and has a molecular formula InGaAs, the alloy comprises GaAlAs and has a molecular formula GaAlAs, or the alloy comprises InGaN and has a molecular formula InGaN, wherein x is any fraction between 0 and 1.

109. The concentration-gradient quantum dot of claim 101, wherein at least one of the first semiconductor and second semiconductor is a compound semiconductor.

110. The concentration-gradient quantum dot of claim 109, wherein the compound semiconductor is CdSe.

111. The concentration-gradient quantum dot of claim 109, wherein the compound semiconductor is CdTe.

112. The concentration-gradient quantum dot of claim 101, wherein the alloy comprises CdSe and CdTe.

113. The concentration-gradient quantum dot of claim 101, wherein the quantum dot is less than 15 nm in diameter.

114. The concentration-gradient quantum dot of claim 113, wherein the quantum dot is less than 8 nm in diameter.

115. The concentration-gradient quantum dot of claim 101, wherein the quantum dot is conjugated to a biological agent.

116. The concentration-gradient quantum dot of claim 115, wherein the biological agent is a biomolecule or a drug.

117. The concentration-gradient quantum dot of claim 116, wherein the biomolecule is selected from the group consisting of a protein, a peptide, a nucleic acid molecule, and a combination thereof.

118. The concentration-gradient quantum dot of claim 101, wherein the concentration-gradient quantum dot has a semiconductor shell.

119. The concentration-gradient quantum dot of claim 118, wherein the semiconductor shell comprises ZnS, CdS, CdSe, CdTe, GaAs, or AlGaAs.

120. The concentration-gradient quantum dot of claim 101, wherein the quantum dot is encapsulated within a polymer bead.

121. The concentration-gradient quantum dot of claim 120, wherein the polymer bead comprises a polymer selected from the group consisting of polystyrene, brominated polystyrene, polyacrylic acid, polyacrylonitrile, polyamide, polyacrylamide, polyacrolein, polybutadiene, polycaprolactone, polycarbonate, polyester, polyethylene, polyethylene terephthalate, polydimethylsiloxane, polyisoprene, polyurethane, polyvinyl acetate, polyvinyl chloride, polyvinyl pyridine, polyvinylbenzyl chloride, polyvinyl toluene, polyvinylidene chloride, polydivinylbenzene, polymethylmethacrylate, polylactide, polyglycolide, poly(lactide-co-glycolide), polyanhydride, polyorthoester, polyphosphazene, polysulfone, and combinations or copolymers thereof.

122. A series of concentration-gradient quantum dots,

wherein each quantum dot comprises an alloy of a first semiconductor and a second semiconductor,

wherein, for each quantum dot, the concentration of the first semiconductor gradually increases from the core of the quantum dot to the surface of the quantum dot and the concentration of the second semiconductor gradually decreases from the core of the quantum dot to the surface of the quantum dot,

wherein the gradient by which the concentration of the first semiconductor increases and the gradient by which the concentration of the second semiconductor decreases from the core of the quantum dot to the surface of the quantum dot varies among the quantum dots of the series,

wherein the size of each quantum dot is within about 5% of the size of the average-sized quantum dot, and

wherein each quantum dot comprises the same semiconductors.

123. The series of concentration-gradient quantum dots of claim 122, wherein each of the quantum dots has a quantum yield that is at least about 15%.

124. The series of concentration-gradient quantum dots of claim 123, wherein the quantum yield is within the range of about 30% and about 60%.

125. The series of concentration-gradient quantum dots of claim 124, wherein the quantum yield is within the range of about 40% and about 60%.

126. The series of concentration-gradient quantum dots of claim 122, wherein each of the first semiconductor and second semiconductor has a lattice parameter that is within about 10% of the mean lattice parameter.

127. The series of concentration-gradient quantum dots of claim 122, wherein at least one of the first semiconductor and second semiconductor is a Group II-Group VI semiconductor or a Group III-Group V semiconductor.

128. The series of concentration-gradient quantum dots of claim 127, wherein the quantum dots comprise an alloy selected from the group consisting of CdSeTe, CdSSe, CdSTe, ZnSeTe, ZnCdTe, CdHgS, HgCdTe, InGaAs, GaAlAs, and InGaN.

129. The series of concentration-gradient quantum dots of claim 128, wherein the alloy comprises CdSeTe and has a molecular formula $CdSe_{1-x}Te_x$, wherein the alloy comprises CdSSe and has a molecular formula $CdS_{1-x}Se_x$, the alloy comprises CdSTe and has a molecular formula $CdS_{1-x}Te_x$, the alloy comprises ZnSeTe and has a molecular formula $ZnSe_{1-x}Te_x$, the alloy comprises ZnCdTe and has a molecular formula $Zn_{1-x}Cd_xTe$, the alloy comprises CdHgS and has a molecular formula $Cd_{1-x}Hg_xS$, the alloy comprises HgCdTe and has a molecular formula HgCdTe, the alloy comprises InGaAs and has a molecular formula InGaAs, the alloy comprises GaAlAs and has a molecular formula GaAlAs, or the alloy

comprises InGaN and has a molecular formula InGaN, wherein x is any fraction between 0 and 1.

130. The series of concentration-gradient quantum dots of claim 122, wherein at least one of the first semiconductor and second semiconductor is a compound semiconductor.

131. The series of concentration-gradient quantum dots of claim 130, wherein the compound semiconductor is CdSe.

132. The series of concentration-gradient quantum dots of claim 130, wherein the compound semiconductor is CdTe.

133. The series of concentration-gradient quantum dots of claim 122, wherein the alloy comprises CdSe and CdTe.

134. The series of concentration-gradient quantum dots of claim 122, wherein each of the quantum dots is less than 15 nm in diameter.

135. The series of concentration-gradient quantum dots of claim 134, wherein the quantum dots are less than 8 nm in diameter.

136. The series of concentration-gradient quantum dots of claim 122, wherein each of the quantum dots are conjugated to a biological agent.

137. The series of concentration-gradient quantum dots of claim 136, wherein the biological agent is a biomolecule or a drug.

138. The series of concentration-gradient quantum dots of claim 137, wherein the biomolecule is selected from the group consisting of a protein, a peptide, a nucleic acid molecule, and a combination thereof.

139. The series of concentration-gradient quantum dots of claim 136, wherein each of the quantum dots is conjugated to a different biological agent, such that each of the different biological agents corresponds to a quantum dot having a unique gradient of the first semiconductor and second semiconductor.

140. The series of concentration-gradient quantum dots of claim 139, wherein each of the biological agents is a biomolecule or a drug.

141. The series of concentration-gradient quantum dots of claim 140, wherein the biomolecules are selected from the group consisting of a protein, a peptide, a nucleic acid molecule, and a combination thereof.

142. The series of concentration-gradient quantum dots of claim 122, wherein each of the concentration-gradient quantum dots has a semiconductor shell.

143. The series of concentration-gradient quantum dots of claim 142, wherein the semiconductor shell comprises ZnS, CdS, CdSe, CdTe, GaAs, or AlGaAs.

144. The series of concentration-gradient quantum dots of claim 122, wherein each of the quantum dots is encapsulated within a polymer bead.

145. The concentration-gradient quantum dot of claim 144, wherein the polymer bead comprises a polymer selected from the group consisting of polystyrene, brominated polystyrene, polyacrylic acid, polyacrylonitrile, polyamide, polyacrylamide, polyacrolein, polybutadiene, polycaprolactone, polycarbonate, polyester, polyethylene, polyethylene terephthalate, polydimethylsiloxane, polyisoprene, polyurethane, polyvinyl acetate, polyvinyl chloride, polyvinyl pyridine, polyvinylbenzyl chloride, polyvinyl toluene, polyvinylidene chloride, polydivinylbenzene, polymethylmethacrylate, polylactide, polyglycolide, poly(lactide-co-glycolide), polyanhydride, polyorthoester, polyphosphazene, polysulfone, and combinations or copolymers thereof.

146. A method of detecting a target in a sample, which method comprises:
  (i) contacting a sample with the concentration gradient quantum dot of claim 115, wherein the biological agent specifically binds to a target in the sample,
  (ii) allowing the biological agent to specifically bind to the target, and
  (iii) analyzing the sample via spectroscopy, thereby obtaining a spectroscopic signature of the sample, wherein the spectroscopic signature is indicative of the presence or the absence of the target in the sample.

147. The method of claim 146, wherein the sample is obtained from a mammal.

148. The method of claim 147, wherein the mammal is a human.

149. The method of claim 147, wherein the mammal has a disease or a condition and the method achieves detection of the disease or the condition.

150. A method of detecting more than one target in a sample, which method comprises:
   (i) contacting a sample with the series of concentration-gradient quantum dots of claim 139, wherein each of the biological agents specifically bind to a different target in the sample,
   (ii) allowing the biological agents to specifically bind to the targets,
   (iii) analyzing the sample via spectroscopy, thereby obtaining a spectroscopic signature of the sample, wherein the spectroscopic signature is indicative of the presence or absence of the more than one target in the sample.

151. The method of claim 150, wherein the sample is obtained from a mammal.

152. The method of claim 151, wherein the mammal is a human.

153. The method of claim 151, wherein the mammal has a disease or a condition and the method achieves detection of the disease or the condition.

154. A method of detecting the location of a target within a sample, which method comprises:
   (i) contacting a sample with the concentration-gradient quantum dot of claim 115, wherein the biological agent specifically binds to a target in the sample,
   (ii) allowing the biological agent to specifically bind to the target,
   (iii) imaging the sample or a section thereof, thereby detecting the location of the target within the sample.

155. The method of claim 154, wherein the sample is obtained from a mammal.

156. The method of claim 155, wherein the mammal is a human.

157. The method of claim 155, wherein the mammal has a disease or a condition and the method achieves a prognosis of the disease or the condition.

158. The method of claim 157, wherein the disease is cancer.

159. A method of detecting the location of more than one target within a sample, which method comprises:

(i) contacting a sample with the series of concentration-gradient quantum dots of claim 139, wherein each of the biological agents specifically binds to a different target in the sample,

(ii) allowing the biological agents to specifically bind to the targets,

(iii) imaging the sample or a section thereof, thereby detecting the location of the more than one target within the sample.

160. The method of claim 159, wherein the sample is obtained from a mammal.

161. The method of claim 160, wherein the mammal is a human.

162. The method of claim 160, wherein the mammal has a disease or a condition and the method achieves a prognosis of the disease or the condition.

163. The method of claim 162, wherein the disease is cancer.

164. A method of monitoring a biological process *in vitro*, which method comprises:

(i) contacting a sample with the concentration-gradient quantum dot of claim 115, wherein the biological agent specifically binds to a target in the sample, wherein the target functions in a biological process,

(ii) allowing the biological agent to specifically bind to the target, and

(iii) imaging the sample or a section thereof over a period of time or before and after a stimulus, thereby monitoring a biological process *in vitro*.

165. The method of claim 164, wherein the sample is obtained from a mammal.

166. The method of claim 165, wherein the mammal is a human.

167. The method of claim 165, wherein the mammal has a disease or a condition and the method achieves detection or prognosis of the disease or the condition.

168. A method of monitoring a biological process *in vitro*, which method comprises:

(i) contacting a sample with the series of concentration-gradient quantum dots of claim 139, wherein each of the biological agents specifically binds to a different target in the sample, wherein each of the targets functions in a biological process,
(ii) allowing the biological agents to specifically bind to the targets, and
(iii) imaging the sample or a section thereof over a period of time or before and after a stimulus, thereby monitoring a biological process *in vitro*.

169. The method of claim 168, wherein the sample is obtained from a mammal.

170. The method of claim 169, wherein the mammal is a human.

171. The method of claim 169, wherein the mammal has a disease or a condition and the method achieves detection or prognosis of the disease or the condition.

172. A method of detecting the location of a target *in vivo*, which method comprises:
(i) administering the concentration-gradient dot of claim 115 to a host, wherein the biological agent specifically binds to a target in the host,
(ii) allowing the biological agent to specifically bind to the target,
(iii) imaging the host, a section thereof, or a cell thereof, thereby detecting the location of the target *in vivo*.

173. The method of claim 172, wherein the host is a mammal.

174. The method of claim 173, wherein the mammal is a human.

175. The method of claim 173, wherein the mammal has a disease or a condition and the method achieves a prognosis of the disease or the condition.

176. The method of claim 172, wherein the location of the target is deep within the host.

177. The method of claim 172, wherein the imaging involves detecting near infrared or far red emission peak wavelengths.

178. A method of detecting the location of more than one target *in vivo*, which method comprises:

(i) administering the series of concentration-gradient dots of claim 139 to a host, wherein each of the biological agents specifically binds to a different target in the host,
(ii) allowing the biological agents to specifically bind to the targets,
(iii) imaging the host, a section thereof, or a cell thereof, thereby detecting the location of the more than one target *in vivo*.

179. The method of claim 178, wherein the host is a mammal.

180. The method of claim 179, wherein the mammal is a human.

181. The method of claim 179, wherein the mammal has a disease or a condition and the method achieves a prognosis of the disease or the condition.

182. The method of claim 178, wherein the location of the target is deep within the host.

183. The method of claim 178, wherein the imaging involves detecting near infrared or far red emission peak wavelengths.

184. A method of monitoring a biological process *in vivo*, which method comprises:
(i) administering the concentration-gradient quantum dot of claim 115 to a host, wherein the biological agent specifically binds to a target in the host, wherein the target functions in a biological process,
(ii) allowing the biological agent to specifically bind to the target, and
(iii) imaging the host, a section, or a cell thereof over a period of time or before and after a stimulus, thereby monitoring a biological process *in vivo*.

185. The method of claim 184, wherein the host is a mammal.

186. The method of claim 185, wherein the mammal is a human.

187. The method of claim 185, wherein the mammal has a disease or a condition and the method achieves detection or prognosis of the disease or the condition.

188. The method of claim 184, wherein the location of the target is deep within the host.

189. The method of claim 184, wherein the imaging involves detecting near infrared or far red emission peak wavelengths.

190. A method of monitoring a biological process *in vivo*, which method comprises:
   (i) administering the series of alloyed semiconductor quantum dots of claim 139 to a host, wherein each of the biological agents specifically binds to a different target in the host, wherein each of the targets functions in a biological process,
   (ii) allowing the biological agents to specifically bind to the targets, and
   (iii) imaging the host, a sample thereof, or a section thereof over a period of time or before and after a stimulus, thereby monitoring a biological process *in vivo*.

191. The method of claim 190, wherein the host is a mammal.

192. The method of claim 191, wherein the mammal is a human.

193. The method of claim 191, wherein the mammal has a disease or a condition and the method achieves detection or prognosis of the disease or the condition.

194. The method of claim 190, wherein the location of the target is deep within the host.

195. The method of claim 190, wherein the imaging involves detecting near infrared or far red emission peak wavelengths.

196. A method of producing a ternary concentration-gradient quantum dot comprising a first semiconductor AB and a second semiconductor AC, wherein A is a species that is common to the first semiconductor and the second semiconductor and B and C are each a species found in only one of the first semiconductor and the second semiconductor, which method comprises:
   (i) providing a first solution under conditions which allow nanocrystal formation to take place,
   (ii) providing a second solution comprising A, B, and C at a molar ratio under conditions which do not allow nanocrystal formation to take place, wherein each of B and C are present in the second solution at a concentration that is reaction-limiting,
   (iii) adding the second solution to the first solution, thereby allowing nanocrystal formation to take place, and

(iv) changing the conditions to conditions that halt nanocrystal growth and formation.

197. A method of producing a series of ternary concentration-gradient quantum dots, wherein each of the quantum dots comprise a first semiconductor AB and a second semiconductor AC, wherein A is a species that is common to the first semiconductor and the second semiconductor and B and C are each a species found in only one of the first semiconductor and the second semiconductor, which method comprises:

(i) providing a first solution under conditions which allow nanocrystal formation to take place,

(ii) providing a second solution comprising A, B, and C at a molar ratio under conditions which do not allow nanocrystal formation to take place, wherein each of B and C are present in the second solution at a concentration that is reaction-limiting,

(iii) adding the second solution to the first solution, thereby allowing nanocrystal formation to take place,

(iv) changing the conditions to conditions that halt nanocrystal growth and formation, and

(v) repeating steps (i)-(iv) at least one time, thereby producing at least one other quantum dot of the series, wherein each time the molar ratio of A, B, and C is different from the molar ration of A, B, and C of the other quantum dots of the series.